

A NOTE UPON THE INSUFFICIENCY OF THE OPERCULUM AS A BASIS
OF CLASSIFICATION IN ROUND-MOUTHED SHELLS.

(Concluded).

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SECOND SERIES.

Operculum subcircular, few whorls, rather quickly widening, nucleus subcentral.

I. Operculum horny.

Genera, *Jamaicia*, *Licina*, *Choanopoma*.

Jamaicia. Operculum horny, exteriorly convex, with few rugose whorls, obliquely striated, sublammellose.

Licina. Operculum not described.

Choanopoma. Operculum horny, subcircular, whorls rather quickly widening, with free external margin, acute, frequently raised into lofty lamella, nucleus subeccentric.

II. Operculum cartilaginous.

Genus, *Adamsiella*.

Adamsiella. Operculum circular, thin, subcartilaginous, with few whorls, gradually increasing, with somewhat free edges, nucleus subcentral.

THIRD SERIES.

Operculum oval or angulated, few whorls, more or less quickly increasing, nucleus eccentric.

I. Operculum shelly.

Genera, *Lithidion*, *Otopoma*, *Cyclostomus*, *Tudora*, *Leonia*.

Lithidion. Operculum subcircular, shelly, whorls rather rapidly increasing, with a subcentral keel, strong, convex, furnished with simple margins.

Otopoma. Operculum horny, solid, few whorls, convex center, simple margin.

Cyclostomus. Operculum suboval, horny, plane, four to five whorls, gradually increasing, simple margin, nucleus subeccentric.

Tudora. Operculum oval, horny, plane, two or three whorls rapidly increasing, obliquely arcuate, striate, or sulcate, nucleus quite eccentric, with the left and lower margin closely fitting to the peristomes.

Leonia. Operculum oval, shelly, externally perconvex, unispiral, nucleus placed near the columellar margin.

II. Operculum cartilaginous, covered externally with a thin shelly layer.

Cistula. Operculum oval, thin, cartilaginous, externally furnished with a thin horny layer, with a few whorls gradually increasing, margin generally free, nucleus eccentric.

III. Operculum entirely cartilaginous.

Chondropoma. Operculum oval, subcartilaginous, plane, few whorls, rapidly increasing, nucleus generally quite eccentric.

IV. Operculum double interiorly concamerated.

Pomatias. Operculum cartilaginous, few-whorled, made up of two laminae, interiorly concamerated.

V. Operculum corneous.

Genera, *Realia*, *Omphalotropis*, *Bourciera*.

Realia. Operculum thin, horny, few-whorled.

Omphalotropis. Operculum thin, horny, few-whorled.

Bourciera. Operculum oval, somewhat solid, horny, with few rapidly increasing whorls.

Later authors have extended this list of genera, but Pfeiffer's synopsis practically embraces the important and distinguishing genera. The force assigned to the operculum as separative of the genera naturally appears exaggerated, when their characters are thus isolated, but in view of the purpose of this paper to emphasize their secondary, or in cases, entirely negligible weight, this isolation serves the more explicit object of fixing attention solely upon the operculate features.

To begin with, in the genus *Cyclotus*, there exist differences in the opercula of many species almost as great as that between the opercula of recognized genera. In the species *C. corrugatum*, Swb. the whorls of the laminae in the operculum are margined by erect incurved slightly striate free fillets, the whole operculum presenting the appearance of a watch-spring; whereas in typical examples of the operculum of *Cyclotus*, the laminae are flat with edges strictly in contact or slightly overlapping, the latter feature becoming extreme in *seminudum*. There is here no essentially different principle of construction involved but the formal contrast in appearance might as safely be invoked to make another genus in the case of *C. corrugatum* (as it has been) so far as opercula offer signs of generic distinction. Troschel and H. and A. Adams have indeed placed this shell, along with *asperulus*, *cingulatus*, *crassus*, etc., in all twenty-five species, in the subgenus *Aperostoma*.

The shelly substance of the operculum of *Cyclotus* is however a quite constant feature. The shelly opercula are found in such small shells as *fodiens*, *humanus*, *parrulus*, *minimus*, where it might be expected that the calcareous secretions would be less complete.

The opercula of the small shells *Alycaeus* and *Diplommatina* are not often found in shells in collections. Where I could examine them under a one-inch objective they certainly offer no determinative differences from the opercula of *Cyclophorus*, and like the latter are horny (corneous). Compare for instance the opercula of *Alycaeus rathousiana*, Hende, *Cyclophorus parapsis*, Benson.

The genus *Pterocyclos* is certainly closely allied to genera *Opisthoporus*, *Spiraculum*, *Rhiostoma*, but the opercula of these four genera exhibit two contrasted forms. Taking *Pterocyclos anguliferus* Soul. as an example of one form, the operculum forms a calcareous button, concave upon the outer side, interiorly filmed by a horny scale covering its entire width, grooved at the sides, and showing on its exposed surface closely wound narrow whorls, throughout obliquely striate. This configuration and structure is quite as naturally and truly referable to the opercula of some species of *Cyclotus* as *C. auriculata*, Kob., etc.

This form of operculum is found in some species of *Opisthoporus* (vide *biciliatus*, Mouss., *birostra*, Pfr.) and the distinction made by H. and A. Adams between the opercula of *Opisthoporus* and *Pterocyclas* is certainly misleading if universally applied. Another more common type of operculum, seen in *Spiraculum*, *Rhiostoma*, some species of *Opisthoporus* and *Pterocyclos* is a spiral lamina, concave interiorly, more or less deep with the free edges of the laminae erect or explanate and horizontal, arising screw-wise steeply around a solid nucleus (*Rhiostoma*) or more spreading with corneous intercalation (*Spiraculum*). The morphology of the shells themselves separates these genera, though it is probable the distinctions should form subgenera, but the opercula present two forms, which while partially restricted are surely not enough so to offer any basis for strict classification.

But the confusion, so far as opercula are considered, does not end here. The opercula of the second type of *Pterocyclos*, *Opisthoporus*, *Spiraculum*, *Rhiostoma*, in substance and structure, is practically repeated in those of *Choanopoma*. Both groups show the exsert, erect, or spreading laminae, the spiral curvature, the union of calcareous and corneous texture, though the inner surface of the operculum in *Choanopoma* is usually flat, and in some instances as *C. pulchrum*, Gray, the coarse expansive character of the whorls contrasts with the analogous feature in *Pterocyclas*, etc.

The operculum of *Leptopoma* is essentially that of many species of *Cyclophorus* (compare *Leptopoma sericatum*, Pfr. with *C. fulguratus*, Pfr. and *C. borneense*, Mtf.). It is membranous, corneous, arcti-spiral suppressedly striate, on the laminae, concave, with a polished inner surface. The fimbriated shaggy exfoliated surfaces of many opercula of the larger *Cyclophorus* (see *C. arthritis*, *C. nilagirianus*, *C. oculus-capri*, *C. tuba*, *C. validus*, etc.) are age characters, and seem also to have some relation to the moist habitats of the animals. This type of operculum is repeated in *Megalomastoma*, though the shell in the latter case is pronouncedly and divergently different (see *M. ventricosum*, *M. verruculosum*.)

Cataulus is in its operculate character identical with the foregoing. Although from the size of the apertures the opercula are small, they are in construction, substance, expression, and microscopic features, inseparable from the opercula of *Cyclophorus*, *Megalomastoma*, and *Leptopoma*. The flatness usually observable in the opercula of the last two genera is shown in *Cyclophorus* in small shells, the concavity of the opercula of the latter genus being the result of the natural curvature produced by the protruding fibres of the larger foot in larger species.

The operculum of *Pupina* is unmistakably indicated in structure, nature, and physical appearance with all the foregoing, its tenuity alone and flatness offering only the most evanescent and unreal discrimination from the other genera. *Pupinella*, *Registoma*, *Callia*, are quite inseparable in their operculate character. *Aulopoma* is a shell very near in external characters to *Pterocyclos*, *Opisthoporus*, *Spiraculum*, *Rhiostoma*, omitting the lip expansion and spiracle, but the operculum is sharply contrasted. The operculum in *Aulopoma* is corneous, consisting of a flat spiral made up of tubular whorls coarsely striate and embracing, cap-like, the margins of the shell aperture. If the distinction of this genus is based upon the operculum it rather forcibly separates a shell from its natural generic position.

In structure, at least, the sub-orbicular operculum of *Otopoma naticoides* Rec., with its cycloidal development with the tangential striæ leaving the whorls and extending outward, but forming flexuous lines on the limits of the last whorl, is repeated in the authentic opercula of *Cyclophorus metabletus* Crosse & Fischer.

The instances of exact repetition in the opercula of *Cyclotus* and *Cyclophorus* are numerous. The operculum of *Cyclotus translucidus*

Sowb. is certainly reproduced in those of *Cyclostoma xanthocheilus*, *C. barclayanus*, *C. campanulatus*. The flat thin spiral, almost equal with the slightly overlapping ascent outward to the last whorl, striate on its exterior edges, is closely repeated in each.

In *Adamsiella grayana* Pfr., *A. variabile* Ad., there is a spiral operculum with exsert laminæ, somewhat multifolded or lamellose on edges, but structurally distinctly like *Choanopoma* and *Opisthoporus*.

The operculum of *Tudora* and *Cistula* with their rapidly increasing whorls, the last expansive and filling one-third of the aperture, nucleus subcentral, are practically identical. The thin substance of the operculum of *Chondropoma* gives it some essential differentiation, but in the theory of its form it is exactly like *Tudora* and *Cistula*. The outer surface of the operculum of *Tudora* is frequently (*T. shepardianus* Ad., *T. pupoides* Morelet) fibrous-rayed, whereas in *megacheilus* its surface is smooth, or obsoletely striate which form is closely imitated by the operculum of *Chondropoma*.

The following table exhibits the substance of the operculum in the genera of round-mouthed shells, as observed in the collection of the American Museum of Natural History, and as given by Pfeiffer. The two columns afford slight differences, but such differences might readily be referred to individual variations in the shells examined by two observers, using different groups of specimens.

SUBSTANCE OF THE OPERCULUM.

<i>Observed in Collection.</i>		<i>Pfeiffer.</i>
Testaceous to subtestaceous. Sub-testaceous in <i>C. crassus</i> , Ad. <i>C. triliratum</i> Pfr., <i>C. rugatus</i> Guppy, <i>C. suturale</i> Swb.	<i>Cyclotus</i> .	Testaceous.
Corneous.	<i>Alycæus</i> .	Sub-testaceous.
Corneous.	<i>Diplommatina</i> .	Sub-testaceous.
Testaceous to Sub-testaceous in <i>P. rupestris</i> Bens.	<i>Pterocyclos</i> .	Sub-cartilaginous.
Not seen.	<i>Craspedopoma</i> .	Corneous.
Corneous.	<i>Aulopoma</i> .	Corneous.
Corneous.	<i>Cyclophorus</i> .	Corneous.
Corneous. Membranous.	<i>Leptopoma</i> .	Membranous.
Corneous.	<i>Megalomastoma</i> .	Corneous.
Corneous.	<i>Cataulhis</i> .	Corneous.
Corneous.	<i>Pupinella</i> .	Corneous.
Corneous.	<i>Pupina</i> .	Membranous.

Corneous.	<i>Registoma.</i>	Corneous.
	<i>Callia.</i>	Membranous.
Corneo-testaceous.	<i>Jamaica.</i>	Corneous.
Not seen.	<i>Licina.</i>	?
Testaceous to Corneo-testaceous.	<i>Choanopoma.</i>	Corneous.
In <i>C. majusculum</i> Morelet the corneous layer is quite intimately and equally developed with the testaceous.		
Corneous.	<i>Adamsiella.</i>	Sub-cartilaginous.
	<i>Lithidion.</i>	Corneous.
Testaceous.	<i>Otopoma.</i>	Corneous.
Testaceous.	<i>Cyclostomus.</i>	Corneous.
Corneous layer quite thick in instances as <i>C. bicarinatum</i> Swb., <i>C. filiosum</i> Swb., <i>C. madagascariense</i> Gray, <i>C. rangelinum</i> , <i>C. xanthocheilus</i> .		
Testaceous to Testaceo-corneous.	<i>Tudora.</i>	Corneous.
Testaceous.	<i>Leonia.</i>	Testaceous.
Testaceous.	<i>Cistula.</i>	Cartilaginous.
Corneo-cartilaginous.	<i>Chondropoma.</i>	Sub-cartilaginous.
Not seen.	<i>Pomatias.</i>	Cartilaginous.
Not seen.	<i>Realia.</i>	Corneous.
Not seen.	<i>Omphalotropis.</i>	Corneous.
Not seen.	<i>Bourciera.</i>	Corneous.
Testaceous to Sub testaceous.	<i>Hybocystis.</i>	
Testaceous.	<i>Cyclotopsis.</i>	
Testaceous to Sub-testaceous.	<i>Ctenopoma.</i>	
Testaceous.	<i>Diplopoma.</i>	

Collections of the Cyclostomacea are often sadly deficient in opercula, and this very interesting feature is as frequently absent as present. It seems most probable that opercula have no exact generic value, and should not be regarded with the extreme importance assigned to them by Pfeiffer, H. & A. Adams, and other authors.

It is hoped that a more detailed and illustrated study of them will be made in the future.

NOTES.

THE WINKLEY COLLECTION OF SHELLS.—“A most gratifying gift was received last June from the Rev. Henry W. Winkley, of Branford, Conn.; it consists of a large series, some 1600 species and